Mobile Money, Entrepreneurship and Labor Dynamics in Developing Countries

A thesis submitted by

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Abstract

In this paper I study the extent to which the adoption of a new payment technology (mobile money) among informal entrepreneurs affects worker outcomes, the labor market structure and aggregate output in developing countries. To do this I develop a quantitative two-sector search and matching model with a formal(salaried) sector and informal(self-employment) sector, where households make salaried and self-employment participation decisions and self-employed workers make mobile money adoption decisions. Leveraging a sample of 49 developing countries, I find that an increase in mobile money adoption among informal workers leads to labor re-allocations from the formal to informal sector, which lead to small and insignificant changes to the unemployment and self-employment rate. Critically, I also find that the labor re-allocations lead to an increase in self-employment output that more than offsets the respective decrease in salaried output. The result is an increase in economy-wide output as mobile money adoption increases. These findings suggest that though mobile money adoption has a limited impact on overall level of unemployment and the size of the salaried and self-employment sectors, it could have a positive effect on the overall level of production. What is more, my results also show that the adoption of mobile money can support policies geared towards inclusive growth. Specifically, in the context of my model mobile money adoption supports both wage and income growth for workers. Importantly, these changes are driven by productivity increases in the self-employment sector, which tends to be a sector comprised of workers who tend to be lower income.

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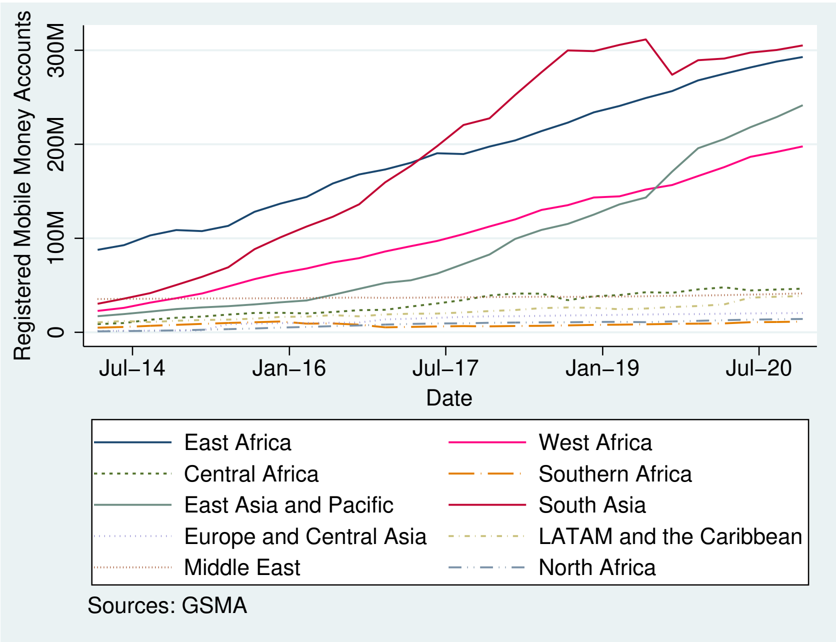
1 Introduction

To what extent does the adoption of a new payment technology among self-employed and largely informal entrepreneurs affect labor dynamics and aggregate outcomes in a developing country? I address this question by focusing on mobile money, a financial innovation which has been spreading rapidly across the developing world over the last decade.

Unlike technologies such as Apple or Google pay, mobile money does not require a smartphone, which means that anyone with a phone and SIM card can use it. It operates via an SMS platform and is simple to operate and use. This has allowed the technology to spread far and wide into rural and poorer regions, where smartphones are uncommon and data connectivity is spotty at best. The technology was initially developed by Kenyan Mobile Network Operator (MNO) Safaricom in 2009 (dubbed M-PESA) but has since expanded across the world (Figure 1).

Figure 1: Mobile Money Growth Across the World



In the early days of adoption, the service was primarily used by workers in cities to send money back home to rural areas. But as the technology has penetrated more deeply into countries—in places like Kenya and Uganda household mobile money adoption hovered around 70% and 55% respectively in 2017—individuals have begun using it for a range of transactions from paying for utilities (solar in rural areas) to sending money for school fees. What is more, mobile money has enabled previously unbanked individuals to create a credit history for the first time, expanding their access to loans and other financial products. In tandem, mobile money has also started to play a bigger role in commerce—wholesalers use the service to pay local farmers for their produce, independent taxis now use it receive mobile payments from customers, and local merchants can now sell their services to customers in different villages, towns and regions without the need to collect payments in person. And larger salaried firms have started using the technology to collect payments for customers, send petty cash to staff and pay for a range of services.

While a burgeoning body of literature has worked to understand to the effects of mobile money adoption on household welfare and consumption, the focus of this paper resides in understanding the extent to which the adoption and use of mobile money among self-employed entrepreneurs affects worker outcomes, the labor market structure and aggregate output in developing countries. In the proceeding section I detail the rationale for narrowing in on informal sector (self-employed) mobile money adoption, but the intuition is as follows: given that self-employed workers are often financially excluded and have limited access to electronic payments, access to new payment technology such as mobile money has the potential to bring significant productivity gains. Consequently, high mobile adoption in this sector could have important implications for aggregate outcomes, particularly in countries with high rates of self-employment, as is the case in most low-income economies.

Specifically, in this study I explore whether greater adoption of mobile money in the self-employment sector leads to lower labor force participation, higher unemployment, and a contraction in output in developing countries. Or does it lead to increased entry among households into self-employment, increased labor force participation, a lower unemployment rate and increased output? I address these questions through the lens of a quantitative framework calibrated to first moments over a range of developing countries (Appendix 1).

Intuitively, increased mobile money adoption could lead to both of the scenarios detailed above. In the first scenario, increased mobile money adoption relaxes the households' budget constraint by increasing the productivity of self-employed firms. A relaxation of the household budget constraint then leads to a contraction in labor force participation, which leads to a contraction in self-employment and an increase in the unemployment rate. Conversely, productivity gains through mobile money adoption in the self-employment sector could significantly boost worker entry into self-employment, thus increasing overall labor force participation, and in turn reduce the unemployment rate. In short, whether greater mobile money adoption has non-trivial quantitative implications for self-employment and unemployment depends on the strength of these mechanisms as well as on the household and firm side factors that shape the labor reallocation process.

To delve into quantitative implications of these mechanisms I develop a two-sector closed-economy model with frictional dynamics where households make salaried and self-employment participation decisions and self-employed workers make mobile money adoption decisions. I calibrate the model using data from a large sample of low and lower-middle income countries with high degrees of self-employment and a baseline level of mobile money adoption. In this framework, self-employed firms with high productivity upon entry adopt a technology (mobile money) using their own labor as an input while also incurring a fixed cost of using the service. The model thus creates an environment with an endogenous share of mobile money adoption which is influenced by the cost of mobile money usage, the effective cost of participation in self-employment, along with other factors that are unique to the model.

The quantitative results from the model are intuitive. Increased self-employment sector mobile money adoption leads to increased entry of individuals into self-employment, which boosts labor force participation and leads to a reallocation of job searchers away from salaried employment to self-employment, which leads to increased self-employment output. In the salaried sector, a reduction in searchers pushes upward pressure on wages, leading firms to reduce the number of vacancy postings. And given that the reduction in vacancy postings is smaller than the reduction in salaried searchers, market tightness increases, leading to an increase in the job-finding probability. Finally, the increase in self-employment is large enough to offset the reduction in vacancy postings, leading to a negligible contraction in the unemployment rate over the mobile money adoption range. Critically, I also find that self-employed sector mobile money adoption is linked with an increase in aggregate output, as the increase in self-employment output more than offsets the respective decrease in salaried output. This is the case even though economy-wide firm productivity decreases due to increased mobile money adoption.

From a policy perspective, my model delivers two main messages. The first is that high mobile money adoption in the self-employed sector can lead to re-allocations of labor between the salaried and self-employment sectors, but these reallocations lead to small and insignificant changes to the overall level of employment, the unemployment rate, and the size of the salaried and self-employment sectors. The second message is that mobile money can viewed as a tool for more inclusive growth. In the context of my model, increased adoption of mobile money improves the fall-back option for workers and boosts the production of self-employed workers—and as a result their incomes—who tend to be lower income and operate their businesses informally.

The rest of this paper is organized as follows. Section 2 provides a more detailed explanation on mobile money and how it is used. In addition, it outlines my rationale for focussing on self-employment sector mobile money adoption, along with some further evidence supporting my modelling approach. Section 3 presents a review of the related literature. Section 4 presents the model, its parametrization and calibration. Section 5 provides a discussion of the results from the model. Section 6 concludes.

2 Literature Review

Financial development can be characterised in several ways, from helping to reduce transaction costs to the relaxation of credit constraints for firms and households. A large literature from Schumpeter (1911) to Levine (1997, 2005) has emphasized the positive influence of financial development on economic growth. However, the research is divided on the effects of financial development on outcomes for different segments of society. On the one hand, some models have determined that the poor have the most to gain from financial development such as a relaxation in credit constraints. This is because the poor have more binding constraints like poor credit histories and a lack of collateral (Aghion and Bolton, 1997; Galore and Zeira, 1993). On the other hand, some models outline how improvements in financial development disproportionately help the rich. These models argue that since the rich have access to formal financial markets, they stand to benefit the most from financial development, while the poor rely primarily on informal markets such as friends and family making them relatively unaffected by financial development (Greenwood and Jankovic, 1990).

It is in this context that I explore the effects of mobile money, a technology that has significantly contributed to financial development across a range of low-income countries over the last decade. Looking at Sub-Saharan Africa, mobile money has spread far and wide across the region since it was first introduced in the Kenyan market by the MNO Safaricom in 2007. As of December 2018, there were 395.7 million registered mobile money subscribers across Africa, of which 145.8m were active (GSMA, 2018). For the same year, the value of mobile money transactions across the continent amounted to $26.8 billion, representing over 65% of mobile money transactions globally. And in Kenya, where mobile money has become practically ubiquitous, the value of mobile money transactions amounted to nearly half of the country's GDP in 2017.

How does mobile money contribute to financial development? Arguably, the technology's largest impact has been on previously unbanked households. Before the arrival of mobile money, many households across Africa had no access to any formal financial services from banking to payments. Now with mobile money, they can transact safely and securely, while also building a credit history and reducing their transaction costs. What is more, mobile money is also providing an avenue for households to gain access to further financial products from savings to credit.

This change in access to financial services for large swathes of households has led to a nascent but burgeoning branch of literature exploring the effects of the new technology on household savings, consumption, and welfare. In a seminal study conducted with a set of 3000 randomly assigned Kenyan households, Jack and Suri (2014) find that households without mobile money access lower their consumption by 7% when faced with an income shock, while consumption among households with mobile money access is unchanged. Additionally, Jack and Suri (2016) find that mobile money increased per capita consumption and lifted 2% of households out of poverty in Kenya.

As the technology has matured there has also been increasing adoption among firms. For example, firms can now use the service to accept payments from customers, pay staff and suppliers. For informal retail firms in particular, mobile money provides a more seamless payment process for consumers and allows them to process payments more quickly than using cash. This development has also led to a small but growing body of research exploring the effects of mobile money adoption on firm performance. Patnam and Yao (2020) explore this in detail by performing a randomized control trial of 3000 informal businesses in India over a period of 6 months. They find that firms that adopted Paytm witnessed a 30% greater improvement in sales than those that did not adopt Paytm.

From a macro perspective, Beck et al. (2018) look at the effects of mobile money adoption among entrepreneurs in Kenya, a market that has one of the highest mobile money penetration rates in the world. To explore how mobile money affects aggregate outcomes, the authors develop a general equilibrium model of entrepreneurial finance, with suppliers and buyers of inputs. In particular, the authors develop a model where mobile money adoption removes the risk of theft but also incurs transaction costs for users. They find that the adoption of mobile money helps relax credit constraints for firms in need of supplier credit, thus creating a positive net effect on entrepreneurial activity and in turn on GDP growth. Specifically, they find that eliminating mobile money in an environment with a 2% probability of theft leads to a macroeconomic output loss of 1.2%. Based on my knowledge, this is the only piece of scholarship evaluating the macroeconomic implications of mobile money adoption.

In this paper, I seek to build on the work undertaken by Beck et al. (2018) to better understand the effects of mobile money on aggregate outcomes. However, while Beck et al. (2018) take a macro-finance approach, I explore how the adoption of mobile money among informal entrepreneurs affects labor outcomes, and in turn other aggregate outcomes.

Accordingly, this paper also contributes to the extensive literature on labor dynamics in developing countries. This body of work is primarily concerned with understanding the causes and dynamics of labor flows between self-employment, salaried employment, and unemployment. In low-income countries, these dynamics are unique in the sense that the self-employment sector is large relative to the overall labor market and for the most part operates outside of the formal sector. Indeed, average self-employment rates in developing countries hover around 45% of the labor force compared to 15% in advanced economies.

On the dynamics of labor markets in developing countries, there is one strand of literature that argues that self-employment in low-income countries is a form of disguised unemployment or safety net (dualistic view) for workers during economic downturns (Fields, 2009, Fajnzylber et al. 2006). Given this perspective, one would expect the self-employment sector to expand during downturns and contract during economic expansions. A separate strand builds on work undertaken by Hart (1979) in Africa, arguing that self-employment is a result of voluntary behaviour exhibited by utility maximizing agents. In this line of argument, there are myriad of reasons why individuals enter self-employment from non-pecuniary benefits (Hamilton, 2000) to lower risk aversion (Jovanovic, 1979), to higher own-capital availability in a market with liquidity constraints. Understanding the role of the self-employment sector in the broader economy is important as it has implications for policy interventions. The model that I develop and discuss in this paper incorporates a self-employment and salaried sector with search frictions and leverages these stylized facts on the labor structures and dynamics in developing countries to test the aggregate effects of increased mobile money adoption among self-employed entrepreneurs. In particular, the model supports the argument that entry into self-employment is a result of voluntary behaviour. Specifically, the results from the model show that increases in self-employed firm productivity through mobile money adoption spurs increased entry into the self-employment sector and leads to a reallocation of job searchers away from salaried employment towards self-employment.

In this context, several scholars in macro-labor have examined the effects of digital and financial innovation on aggregate labor dynamics in developing countries. For example, in a recent study Finklestein-Shapiro and Mandelman (2021) explore the effects of firm level digital adoption on labor dynamics in countries with large self-employment sectors. To do this, they leverage a dynamic general equilibrium model with search and matching frictions, calibrated to a set of moments from low-income countries such as size of the self-employment sector relative to the labor force. They find a strong and negative link between firm digital adoption and self-employment rates. And on the effects of financial shocks on labor market dynamics, Finklestein-Shapiro and Mandelman (2016) finds that countercyclical remittances relax households' budget constraints, thus reducing the shock to household consumption and lowering overall participation in the labor market during periods of economic distress. In turn, the reduction in labor supply during downturns pushes upward pressure on salaried firm wages leading firms in the salaried sector to hire less, resulting in an increase in unemployment.

With this study, I contribute to the above-mentioned macro-labor literature by developing and measuring the quantitative implications of a novel theoretical foundation, which incorporates endogenous adoption of mobile money among self-employed entrepreneurs. As far as I'm aware, this paper represents the first attempt to quantify the macroeconomic implications of mobile money adoption in the informal sector and the first to evaluate the effects of mobile money on employment dynamics in a developing country.

3 Background

In this section I provide further detail on mobile money and how it is used. In addition, I provide some high-level intuition for the study's focus on self-employment sector mobile money adoption, along with empirical evidence to support my modelling approach.

3.1 Overview of Mobile Money

3.1.1 Customer Experience

As outlined in the introduction, mobile money is an SMS based platform, which allows users to make and receive payments on any phone with a SIM card. With mobile money users can perform several transactions through their mobile money accounts. The most critical transactions are: 1) Send money to other mobile money users 2) Withdraw and Deposit cash with an agent 3) Pay for a service (Restaurant, Utility, etc.).

Users incur costs either when they send money or when they withdraw cash from their mobile money accounts. They are also notified of all transactions via SMS, which includes details on the amount sent or received and the respective fees. Users of the service can also withdraw and deposit cash with registered agents, who are generally based in kiosks in areas where there is some baseline usage of the service among the local population. For reference, the number of mobile money agents in Kenya grew 148% from March 2007 to December 2014, while the number of mobile money users grew 307% and reached 25 million by 2014 (Beck et al., 2018). Finally, with mobile money users can also pay for a range of services from utilities to restaurants. And more recently, mobile money providers have been offering further services beyond payments including savings and lending products (FSD Africa, 2015).

3.1.2 Primary Service Providers and Partnerships

Mobile money services were first launched by MNOs such as Safaricom in Kenya. In this form of business model, the MNO provides the bulk of the services across the value chain from customer registration to payment processing, while also partnering with a local bank to hold deposits. But as the services have grown in popularity other models have emerged. For example, traditional banks such as Equitel in Kenya have partnered with MNOs to offer mobile payments to their customers, and foreign and local operated fintech firms have launched smartphone app-based payments services across the region.

3.2 Self-Employment Sector Adoption of Mobile Money

3.2.1 Intuition

Within the confines of this paper, I focus on self-employment sector adoption of mobile money. The rationale for focusing on informal firms is as follows. First, in developing countries the self-employment sector employs a significant percentage of the labor force. Specifically, in the data I use the average self-employment rate represents 64% of overall labor force participation. As such, one would expect any broad-based changes in this sector to have non-negligible macroeconomic implications. And second, given that self-employed workers are largely informal and predominantly engage in activities such as small-scale retail and trade one would expect efficiency gains in payments to improve worker productivity. For example, a buyer that needs to make a payment to a supplier in a different village can leverage mobile money to save on transport cost.

3.2.2 Modelling Self-Employment Sector Mobile Money Adoption—Evidence from Kenya

As mentioned in the introduction, to parse out the effect of self-employment sector mobile adoption, I develop a two-sector model where households make salaried and self-employment participation decisions and self-employed workers make mobile money adoption decisions. Specifically, self-employed workers that are more productive adopt mobile money and pay a fixed cost for using the service, while those below the endogenous productivity threshold do not adopt the technology. The model is then calibrated to the average self-employed firm mobile adoption rate across a range of developing countries.

To support the theoretical basis of this model, I provide empirical evidence on the following: 1) baseline adoption rates of mobile money among self-employed firms, which is necessary for my calibration strategy 2) productivity differentials between self-employed firms that adopt mobile money and those firms that do not adopt the technology. For baseline adoption rates, I provide evidence that household level adoption of mobile money, which is the only publicly available country-level data on mobile money adoption, is a good baseline proxy for self-employment adoption of mobile money. And for productivity differentials across self-employed firms, I provide evidence that self-employed firms with higher productivity levels are more likely to use mobile money.

To achieve this, I analyze data from the Kenya FinAccess 2016 household survey, which includes survey responses from over 8000 individuals across Kenya on several questions from occupation to usage of mobile money. I leverage data from Kenya as it is a country with arguably the best data on mobile money adoption and it is also the country with one of the highest mobile money penetration rates in the world.

Using a formal regression analysis, I test whether self-employed workers in Kenya are more likely to adopt mobile money than other individuals, ceteris paribus. In addition, I develop a regression model to test whether more productive self-employed individuals are more likely to adopt mobile money than less productive workers. For the first model I regress M-PESA use as an indicator on a binary indicator of whether a worker is self-employed or not and a set of individual-level characteristics: income, gender, education, age, religion and urban/rural. The results from this regression can be found column 2 of

Table 1, which shows that there is a positive correlation (statistically significant at 1%) between self-employment and the likelihood of adopting mobile money. This result thus provides evidence that self-employed workers adopt mobile money at a higher rate than the average individual, supporting the use of household level adoption of mobile money as a baseline level of mobile money adoption in the self-employment sector.

For the second model, I regress M-PESA use on the log productivity of the worker, where only self-employed workers are included in the regression. The results for this model can be found in column 1 of Table 1, demonstrating (statistically significant at 1%) that more productive self-employed workers have higher rates of mobile money adoption than less productive self-employed workers, ceteris paribus. This result supports my modelling approach, where self-employed workers make a mobile money adoption decision based on their productivity upon entry into self-employment.

Table 1: Mobile Money Adoption In Kenya

	(1)	(2)
logincome	0.545***	0.517***
	(0.065)	(0.024)
urban	0.462***	0.602***
	(0.144)	(0.056)
tertiaryeduc	0.348	1.325***
	(0.632)	(0.286)
christian	0.956***	1.201***
	(0.166)	(0.068)
male	-0.062	0.195***
	(0.160)	(0.057)
secondaryeduc	0.995***	1.215***
	(0.244)	(0.099)
age	0.141***	0.124***
	(0.028)	(0.009)
age^2	-0.002***	-0.001***
	(0.000)	(0.000)
self-employed		0.554***
		(0.078)
Constant	-7.176***	-7.607***
	(0.748)	(0.252)
R-Squared	0.155	0.237
Observations	1582	8506

Notes: Standard errors in parentheses:* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable is the probability of mobile money adoption. Column 1 displays regression results for a logit model of mobile money on income for self-employed inviduals only. Column 2 displays regression results for logit model of mobile money on income and controls for entire sample.

4 The Model

The model in this paper builds on the framework presented in Finkelstein Shapiro and Mandelman (2021), where instead of salaried firms making production technology decisions, self-employed firms make payment technology decisions.

The economy is made up a representative household, where households make decisions about whether to participate in labor force. The economy is also composed of two main sectors: a salaried sector and a self-employment sector. Self-employed firms use labor as an input to production while salaried firms use both labor and capital. Both sectors are characterized by production functions that are constant returns to scale. Finally, there is costly matching between firms and households as well as costs for households to search for salaried sector or self-employment opportunities.

The creation of self-employed firms is endogenous and subject to barriers to entry where workers choose whether to adopt a new payment technology (mobile money) based on their productivity upon entry. Self-employed firms only adopt the payment technology if their productivity is above a specific threshold. At the same time, these more productive firms pay a fixed cost to use the payment technology.

The result of this framework is an endogenous share of self-employed workers that adopt mobile money, where the share of adoption is affected by the costs of searching for self-employment opportunities and the cost of adopting the payment technology (mobile money).

With regards to households, members have a sequence of two choices. First, they choose whether to participate in the labor market. And second, they choose whether to search for opportunities in self-employment or salaried employment. Individuals who become self-employed create owner run firms comprised of one individual, where they use their own labor to produce and earn profits based on what they produce. On the other hand, individuals who enter salaried employment earn a standard wage in exchange for labor. The presence of search frictions in labor market results in equilibrium unemployment in this model.

4.1 Output aggregator:

Within this economy, a final goods aggregator decides on the overall level of salaried and self-employment output to solve the following: $\Pi_{y,t} = [Y_t - Y_{s,t}p_{s,t} - Y_{e,t}p_{e,t}]$, subject to: $Y_t = [Y_{s,t}^{\frac{\phi_y - 1}{\phi_y}} + Y_{e,t}^{\frac{\phi_y - 1}{\phi_y}}]$, where $\phi_y > 1$ is the elasticity of substitution between self-employment and salaried output. Consequently the first order conditions are: $Y_{s,t} = (p_{s,t})^{-\phi_y} Y_t$ and $Y_{e,t} = (p_{e,t})^{-\phi_y} Y_t$.

4.2 Households and self-employment

4.2.1 Overview of the Household problem

Households own all firms and make labor force participation decisions by deciding the share of household members to send to search for salaried or self-employment opportunities. The search process is subject to an entry cost, which in the context of the model is defined as the probability that a searcher will become employed in either the self-employment sector or the salaried sector. Put another way, this can be seen as an effective cost, which in the self-employment sector is represented by ϕ_e. Households that enter into employment either supply labor n_s in exchange for a wage w_s in the salaried sector, or they create self-employed firms where the input to self-employment is n_e, which is the labor effort of the self-employed worker. As such, in the context of the model, there is an endogenous number of monopolistically competitive self-employed firms where each self-employed firm produces a differentiated output good $y_{j,t}$ and witness an effective cost ϕ_e prior to entering into self-employment. Total self-employed output is given by $Y_{e,t} = (\int_{\zeta \in Z} (y_{j,t}(\zeta))^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}}$.

4.2.2 Self-employment Mobile Money Adoption Decision

Basic Structure: Specifically, upon entry into self-employment, workers make a decision on whether or not to adopt mobile money based on their productivity. Put another way, if owner-only firms have a productivity greater than a threshold productivity $a_{i,t}$, they then adopt mobile money for use in their owner-only business. Self-employed firms above the productivity threshold are labelled as i firms, while firms below the threshold are labelled as r firms. The measure of i and r self-employed firms is given by: $n_{i,t} = [1 - G(a_{i,t})]n_{e,t}$ and $n_{r,t} = G(a_{r,t})n_{e,t}$ respectively.

Self-employed firm profits: I can write self-employed firm profits for i and r firms in the following way:

$$d_{i,t}(a) = (\rho_{i,t}(a) - \frac{mc_{i,t}}{a_{i,t}})y_{i,t}(a) - f_i \tag{1}$$

$$d_{r,t}(a) = (\rho_{r,t}(a) - \frac{mc_{r,t}}{a_{r,t}})y_{r,t}(a) \tag{2}$$

The key variables listed above are the following: $\rho_{j,t}$ is the real price, $mc_{j,t}$ is the marginal cost, $y_{j,t}$ is the firm output, and f_i is the fixed cost of using mobile money for i firms. On profits, for a self-employed firm to be indifferent when faced with the decision to adopt mobile money it is necessary that $d_{i,t}(a) = d_{r,t}(a)$. Finally, I define total firm profits as: $d_t(a) = d_{i,t}(a) + d_{r,t}(a)$.

Optimal pricing: I can write the demand function for firm j's output as: $y_{j,t}(a) = (\frac{\rho_{j,t}}{p_{e,t}})^{\epsilon} Y_{e,t}$ $\in (i, r)$. In this equation $\epsilon > 1$ is the elasticity of substitution between self-employment output varieties and $p_{e,t}$ is the relative price of aggregate self-employment output. With the profit function above I can represent the optimal price for each self-employed firm as: $\rho_{j,t} = \frac{\epsilon}{\epsilon-1}\frac{mc_{j,t}}{a_{j,t}} \in (i, r)$.

Self-employment averages: Here I follow Finkelstein Shapiro and Mandelman (2021) to find the averages for self-employed firms. Doing this, I find two idiosyncratic productivity levels, one for i self-employed firms with productivity level $a_{i,t}$ which can be written as $\widetilde{a}_{i,t} = [\frac{1}{1-G(a_{i,t})}\int_{a_{i,t}}^{\infty} a^{\epsilon-1} dG(a)]^{\frac{1}{\epsilon-1}}$ and one for r firms which can be written as: $\widetilde{a}_{r,t} = [\frac{1}{G(a_{i,t})}\int_{amin}^{a_{i,t}} a^{\epsilon-1} dG(a)]^{\frac{1}{\epsilon-1}}$. Next I can also write average self-employed profits as: $\widetilde{d}_t = \frac{n_{i,t}}{n_{e,t}}\widetilde{d}_{i,t} + \frac{n_{r,t}}{n_{e,t}}\widetilde{d}_{r,t}$, where $\widetilde{d}_{i,t} = d_{i,t}(\widetilde{a}_{i,t})$ and $\widetilde{d}_{r,t} = d_{r,t}(\widetilde{a}_{r,t})$.

Similarly, I calculate average prices as: $\widetilde{p}_{i,t} = p_{i,t}(\widetilde{a}_{i,t})$ and $\widetilde{p}_{r,t} = p_{r,t}(\widetilde{a}_{r,t})$ where the relative price of aggregate self-employment output is written as: $p_{e,t} = [n_{i,t}(\widetilde{p}_{i,t})^{1-\epsilon} + n_{r,t}(\widetilde{p}_{r,t})^{1-\epsilon}]^{\frac{1}{1-\epsilon}}$. Finally, I can also write total aggregate output for self-employment as: $Y_{e,t} = (n_i(\widetilde{y}_{i,t})^{\frac{\epsilon-1}{\epsilon}} + n_r(\widetilde{y}_{r,t})^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}}$.

4.2.3 Setup of Households Problem and Optimality Conditions

Households choose consumption c_t, the measure of households who search for self-employment $s_{e,t}$, the measure of households who search for salaried employment $s_{s,t}$, the desired number of individuals in self-employment $n_{e,t+1}$ in the next period and finally the desired number of individuals to send into salaried employment $n_{s,t+1}$ in the next period to maximize the following objective function:

$$\sum_{t=0}^{\infty} \beta^t [u(c_t) - h(l_{fp_{e,t}}, l_{fp_{s,t}})] \tag{3}$$

Subject to the budget constraint:

$$c_t = w_{s,t} n_{s,t} + \tilde{d}_t n_e + \Pi_{s,t} + \Pi_{y,t} \tag{4}$$

The evolution of salaried employment:

$$n_{s,t+1} = (1 - \rho_s)[n_{s,t} + s_{s,t} f(\theta_{s,t})] \tag{5}$$

The evolution of self-employment

$$n_{e,t+1} = (1 - \rho_e)[n_{e,t} + s_{e,t} \phi_e] \tag{6}$$

In the equations listed above, β is the subjective discount factor, $h(l_{fp_{e,t}}, l_{fp_{s,t}})$ is the disutility of labor, whose inputs are labor force participation in both self-employment and salaried employment. Labor force participation is a function of the sum of workers and searchers across both employed categories: $lfp_{e,t} = n_{e,t} + s_{e,t}$ for self-employed firms and $lfp_{s,t} = n_{s,t} + s_{s,t}$ for salaried firms.

Looking at the budget constraint, $\tilde{d}_t n_e$ represents average profits for self-employed firms, $\tilde{d}_t$ is the average profits of the self-employment sector, $\Pi_{s,t}$ are the profits for salaried good firms and $\Pi_{y,t}$ are aggregate profits.

And finally, for the evolution of salaried and self-employment, $f(\theta_{s,t})$ is the job filling rate which is a function of market tightness $\theta_{s,t}$, while in the equation for self-employment evolution, ϕ_e is the effective cost of searching for a self-employment opportunity.

Optimality conditions: The result of the first order conditions is the following:

$$\frac{h_{lfpe,t}}{u'(c_t)} \frac{1}{\phi_e} + f_e = (1 - \rho_e) \Xi_{t+1|t} [\tilde{d}_{t+1} + f_e + \frac{h_{lfpe,t+1}}{u'(c_{t+1})} (\frac{1}{\phi_e} - 1)] \tag{7}$$

And a labor force participation decision for salaried workers is:

$$\frac{h_{lfps,t}}{u'(c_t)} \frac{1}{f(\theta_{s,t})} = (1 - \rho_s) \Xi_{t+1|t} [w_{s,t+1} + \frac{h_{lfps,t+1}}{u'(c_{t+1})} (\frac{1}{f(\theta_{s,t+1})} - 1)] \tag{8}$$

The intuition for the equilibrium conditions is as follows: households equate the marginal cost of sending one more individual to participate in the labor market to the marginal benefit, which is represented by the sum of discounted self-employed firm profits, the continuation value of staying in self-employment in the next period and the disutility of participating in self-employment.

With regards to salaried employment, households equate the marginal cost of sending one more household to participate in salaried work to the marginal benefit, which is represented by the sum of the discounted wage, the benefit of staying in a salaried employment in the next period and the disutility of participating in salaried employment.

4.3 Salaried Production

Salaried firms post vacancies $v_{s,t}$ decide on the level of capital stock in the next period k_{t+1} and the desired level of employment in the next period $n_{s,t+1}$ to maximize:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} z_t p_{s,t} F(n_{s,t}, k_t) - w_{s,t} n_{s,t} - \psi_s v_{s,t} - i_t \tag{9}$$

subject to law of motion of salaried employment:

$$n_{s,t+1} = (1-\rho_s)[n_{s,t} + v_{s,t} q(\theta_{s,t})] \tag{10}$$

And subject to capital accumulation constraint:

$$i_t = k_{t+1} - (1-\sigma)k_{it} \tag{11}$$

In the above $i_t = k_{t+1} - k_t$ is investment, ψ_s is cost of posting vacancies for the firm, $w_{s,t}$ is the real wage paid to workers, ρ_s is the job separation probability, $F(n_{s,t}, k_t)$ is a constant returns to scale production function and z_t is the exogenous productivity level of the salaried sector. In the law of motion of salaried employment $q(\theta_{s,t})$ is the job filling probability and $\theta_{s,t}$ is market tightness. And in the capital accumulation constraint, $0 < \sigma_i < 1$ is the depreciation rate of capital.

Optimality Conditions: The salaried firms optimality conditions yield a standard job creation condition:

$$\frac{\psi_s}{q(\theta_{s,t})} = (1-\rho_s)[z_{t+1} p_{s,t+1} F_{n_s,t+1} - w_{s,t+1} + \frac{\psi_s}{q(\theta_{s,t+1})}] \tag{12}$$

And a standard Capital Euler condition:

$$1 = [z_{t+1} F_{k,t+1} p_{s,t+1} + (1-\sigma)] \tag{13}$$

The intuition for the equilibrium conditions is as follows: salaried firms equate the marginal cost of creating a vacancy, which is a function of the vacancy cost and the job filling rate, to the marginal benefit, which is the sum of the discounted marginal revenue minus the real wage and plus a saving of not having to post a vacancy in the next period.

4.4 Matching and Nash Bargaining

4.4.1 Matching Functions:

The matching function is a constant to returns to scale production function: $m(s_{s,t}, v_{s,t})$, where the input variables are the number of salaried searchers $s_{s,t}$ and vacancy postings $v_{s,t}$ in the salaried sector. In addition, the job finding probability can be represented as: $f(\theta_s, t) = \frac{m(s_{s,t}, v_{s,t})}{s_{s,t}}$ and the job filling probability $q(\theta_{s,t}) = \frac{m(s_{s,t}, v_{s,t})}{v_{s,t}}$.

4.4.2 Nash Bargaining

For Nash bargaining I look at the benefit to the representative firm of having an additional salaried worker, along with the benefit to worker of having a salaried job. I then use these functions to solve for the Nash wage.

The benefit to the firm of having a salaried worker is:

$$J_t = z_t p_{s,t} F_{n_{s,t}} - w_{s,t} + (1-\rho_s)(J_{t+1}) \tag{14}$$

And the value of having a salaried job for the worker is:

$$W_t = w_{s,t} - \frac{h_{lfp_{s,t}}}{u'(c_t)} + (1-\rho_s)(W_{t+1}) \tag{15}$$

Next using $0 < v < 1$ as the bargaining power of workers, the Nash wage for salaried employment can be shown as: $(1-v)W_{s,t} = vJ_{s,t}$. Thus, we can solve:

$$(1-v)W_{s,t} = vJ_{s,t} \tag{16}$$

Plugging in the value functions we get:

$$(1-v)(w_{s,t} - \frac{h_{lfp_{s,t}}}{u'(c_t)} + (1-\rho_s)W_{t+1}) = v(z_t p_{s,t} F_{n_{s,t}} - w_{s,t} + (1-\rho_s)J_{t+1}) \tag{17}$$

Leveraging the fact that $(1-v)W_{s,t} = vJ_{s,t}$ we can rearrange the above to get:

$$(1-v)(w_{s,t} - \frac{h_{lfp_{s,t}}}{u'(c_t)} + vJ_{t+1} = v(z_t p_{s,t} F_{n_{s,t}} - w_{s,t+1} + (1-\rho_s)J_{t+1}) \tag{18}$$

Simplifying:

$$(1-v)(w_{s,t} - \frac{h_{lfp_{s,t}}}{u'(c_t)}) = v(z_t p_{s,t} F_{n_{s,t}} - w_{s,t}) \tag{19}$$

Solving for $w_{s,t}$ we get:

$$w_{s,t} = v z_t p_{s,t} F_{n_{s,t}} + (1-v)\frac{h_{lfp_{s,t}}}{u'(c_t)} \tag{20}$$

4.5 Closing the model

To close the model I can write the resource constraint for the economy as

$$Y_t = c_t + \psi_s v_{s,t} + i_t + f_i n_i \tag{21}$$

where on the left-hand side I have overall output and the right-hand side is the sum of consumption, vacancy posting costs, investment and the cost of adopting mobile money for self-employed firms.

5 Quantitative Analysis

5.1 Calibration

Functional forms The salaried production function is Cobb-Douglass: $y_{s,t} = z_t(n_{s,t})^{1-\alpha}(k_t)^{\alpha}$, utility over consumption is CRRA: $\frac{c_t^{1-\sigma_c}}{1-\sigma_c}$ and the disutility from salaried and self-employment labor is:

$h(l_{fp_{e,t}}, l_{fp_{s,t}}) = \frac{(\kappa_e(l_{fp_{e,t}})+\kappa_s(l_{fp_{e,t}}))^{\frac{1}{1+\chi}}}{1+\frac{1}{\chi}}$ where $\sigma_c, \kappa_e, \kappa_s, \chi > 0$. I also assume Cobb-Douglass for the matching function where $m_{s,t} = M_s(s_{s,t})^{\xi_s}(v_{s,t})^{1-\xi_s}$ where $\xi_s > 0$. And following the macro literature on endogenous firm entry (Ghironi and Melitz, 2005) and Finkelstein Shapiro and Mandelman (2021), I leverage a Pareto distribution for $G(a) = 1 - (\frac{a_{min}}{a})^{k_p}$ with parameter $k_p > \epsilon - 1$ for the distribution of idiosyncratic productivity among self-employed firms.

Parameters from literature Following Finkelstein Shapiro and Mandelman (2021) I set the risk aversion parameter $\sigma_c = 2$ (alternative values for σ_c do not change my main findings-Appendix 3), subjective discount factor $\beta = 0.985$, the capital depreciation rate $\delta_i = 0.025$, the salaried employment and self-employment separation rates to $\rho_e = 0.03$ and $\rho_s = 0.05$, and the elasticity of labor supply on the extensive margin $\chi = 0.26$. For the elasticity of substitution between self-employment output varieties, I again follow Finkelstein Shapiro and Mandelman (2021) by setting $\epsilon = 6$, which is grounded in the level of salaried firm markups in developing countries. However, for self-employed firms one would expect the elasticity of substitution between output varieties to be even higher, given that most self-employed workers operate in areas of business such as retail and small-scale trade. As such, I also include results with higher ϵ, which I show has little marked change on the results (Appendix 3). I then set $k_p = 6.5$ (which satisfies $\epsilon - 1 < k_p$) and the worker bargaining power $\upsilon = 0.5$, which is the norm in labor search models.

I then proceed by setting the minimum level level of idiosyncratic productivity among self-employed firms to $a_{min} = 1$, and also set the exogenous sectoral productivity for i self-employed firms z_{ei} =1. Lowering both values does not affect the results significantly. Finally, I set $\phi_y = 6$, which signals a relatively high elasticity of substitution between salaried and self-employment output. This again follows Finkelstein Shapiro and Mandelman (2021), who base this parametrization on World Bank evidence, which implies stiff competition between informal and formal firms. I demonstrate that lowering/increasing ϕ_y has little impact on the results (Appendix 3).

Self-Employed Firm Adoption of Mobile Money Recall that the interest of this study is to understand the effect of mobile money adoption among self-employed firms on aggregate dynamics. Thus, I need to calibrate the model to some value of n_i/n_e which is the ratio of self-employed firms that adopt mobile money to the total number of self-employed firms. Unfortunately, firm-level mobile money adoption data for both formal and informal self-employed firms is sparse and unreliable. To get around this I use household-level adoption data of mobile money from the IMF's financial access survey. Specifically, this data shows the number of active mobile money accounts per 1000 households for a range of countries. I also use country data from 2017, given this year had better reported data than other years. With this calibration, I assume that self-employed firms will be greater adopters of mobile money than households, which is supported by the analysis I undertook in the background section, where I showed that self-employed individuals have a greater probability of adopting mobile money than individuals that are not self-employed, ceteris paribus. This analysis supports the use of household level mobile money adoption as a good baseline proxy for self-employed firm adoption of the service.

Calibrated Parameters My objective is to illuminate the quantitative mechanisms underlying the empirical relationships between mobile money adoption, self-employment, salaried employment and unemployment. In this context, I calibrate several parameters to first moments in the developing world country data. Specifically, I calibrate the parameters $\phi_e, \kappa_e, \kappa_s, \chi, \psi, \xi, f_i, z_{er}, g$ such that the model targets the below:

1. Average self-employed firm adoption rate of mobile money of 17.3% (IMF financial access survey)
2. Average labor force participation rate of 63.4%. (World Bank Development Indicators)
3. Average self-employment as a percentage of labor force participation of 63.8% (World Bank Development Indicators)
4. Average unemployment rate of 6.5% (World Bank Development Indicators)
5. Total vacancy posting costs of roughly 1 percent of output (Finkelstein Shapiro and Mandelman, 2021)
6. Finally the value of ϕ_e is equated the value of 4 months wages, which is in line with the setup costs for self-employed workers (Finkelstein Shapiro and Mandelman, 2021)

The resulting values for the calibrated parameters are $\phi_e = 1.5171, \kappa_e = 0.1894, \kappa_s = 3.5087, \chi = 0.2245, \psi = 0.0203, \xi = 0.26, f_i = 0.0244, z_{er} = 0.9331, g = 0.2$.

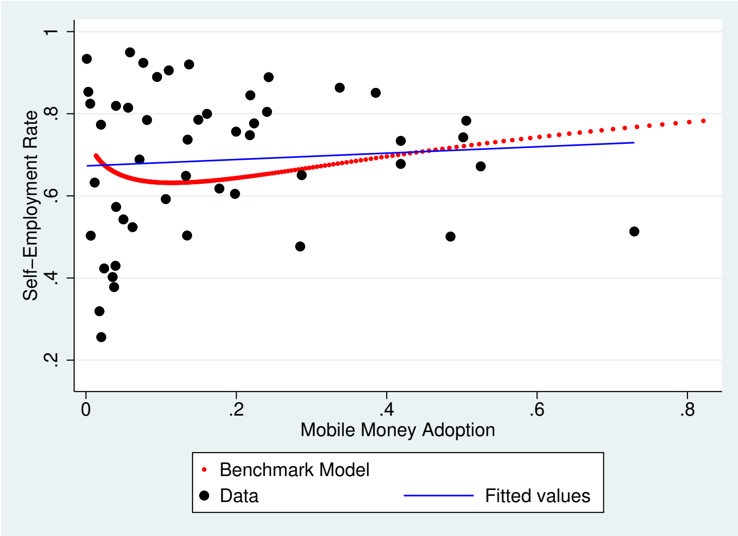
I also note that I had to calibrate the cost f_i as there is no straightforward way to calculate the fixed cost of mobile money usage. Indeed, the closet proxy is the cost of low usage mobile cellular, which in 2021 stood at 5.6% of monthly Gross National Income (GNI) per capita in low-income countries (ITU, 2021).

5.2 Self-employment Mobile Money Adoption and Labor Markets: Data vs. Model

To test how well the model works in relation to the data, I reduce the fixed cost of mobile money adoption (f_i), which effectively reduces the threshold of mobile money adoption. This process creates linkages between the adoption rate (n_i/n_e) and the cost of mobile money, along with other outcomes of interest such as self-employment and unemployment. Figures 2 and 3 plot the model prediction (red line) versus the data trend (blue line). Figure 2 demonstrates the relationship between self-employment and mobile money adoption, while Figure 3 shows the relationship between unemployment and mobile money adoption.

Under my calibration strategy the model generates a weak and positive relationship between self-employment and mobile money adoption and a weak and negative relationship between mobile money adoption and unemployment. Both results are consistent with the patterns observed in developing countries. I also observe slight curvature in the baseline model prediction at lower levels of mobile money adoption, which is a result of the baseline parameters for elasticity of substitution between output varieties and the lower elasticity of substitution between salaried and self-employment output. Modifying the elasticity of substitution between output varieties ϕ_y reduces the curvature in the model results, which can be seen in Appendix 3.

Figure 2: Mobile money adoption and self-employment: benchmark vs. data



Note: Mobile money adoption is measured as a ratio of total active mobile money accounts divided by the number of households in the country.

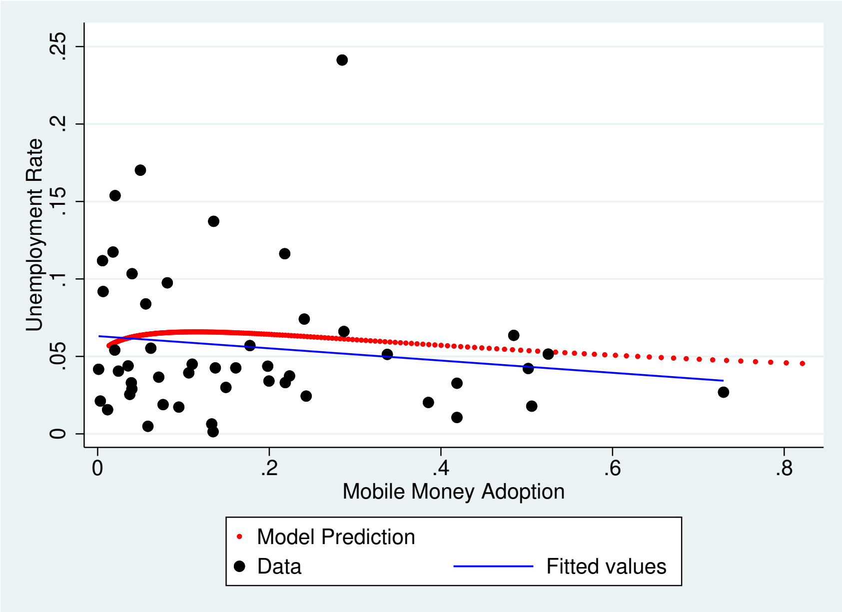
5.3 Self-Employment Mobile money Adoption and Labor Markets: Economic Mechanisms

To better understand the underlying mechanisms of the model, I present steady state results for a range of model variables as I change n_i/n_e (i.e. as I increase mobile money adoption). These are shown in Figure 4. As f_i falls, the number of self-employed firms n_e expands and a greater share of those firms adopt mobile money. Households respond to this change by reallocating job searchers towards self-employment opportunities and away from salaried employment opportunities: i.e. the ratio of self-employment job searchers to the overall labor force participation (s_e/LFP) increases. At the same time, this results in a change in the composition of the unemployment rate away from salaried searchers towards self-employment searchers. In addition, the decrease in salaried searchers pushes upward pressure on wages, which also leads salaried firms to reduce their overall vacancy postings.

Quantitatively, given that the reduction in vacancy postings is smaller than the reduction in salaried searchers, market tightness increases, leading to an increase in the job-finding probability. In addition, the increase in self-employment is large enough to offset the reduction in vacancy postings, leading to a negligible contraction in the unemployment rate over the mobile money adoption range.

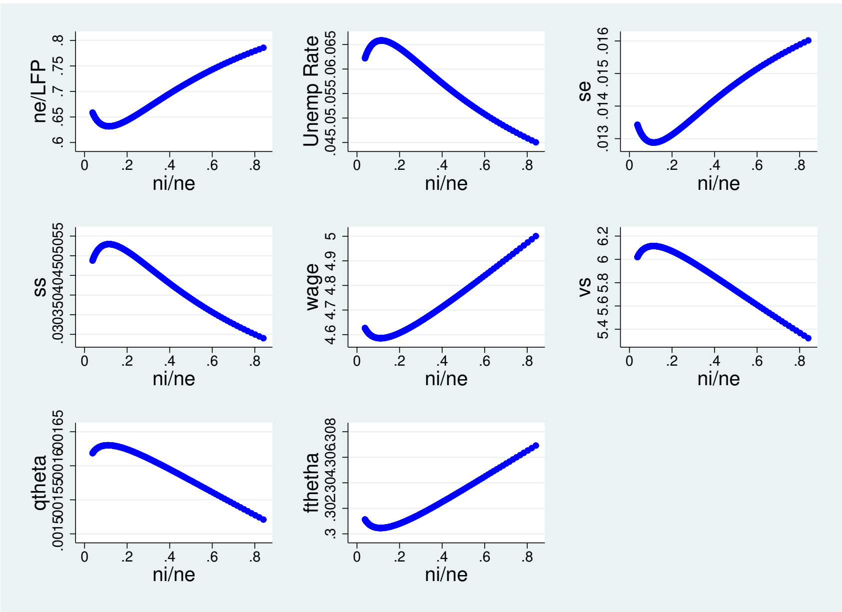
Finally, looking at output and productivity, as I change n_i/n_e self-employment productivity increases, while overall economy wide labor productivity decreases. This makes intuitive sense as an increase in n_i/n_e leads to an increase in more productive n_i firms. At the same time, a shift in labor from salaried to self-employment pushes downward pressure on economy-wide productivity as self-employed firms are less productive than salaried firms. Interestingly, in this backdrop I find that overall economy output increases, as the increase in production in self-employment more than offsets the decline in salaried employment, which is largely a result of a strong increase in overall labor force participation.

Figure 3: Mobile money adoption and unemployment: benchmark vs. data



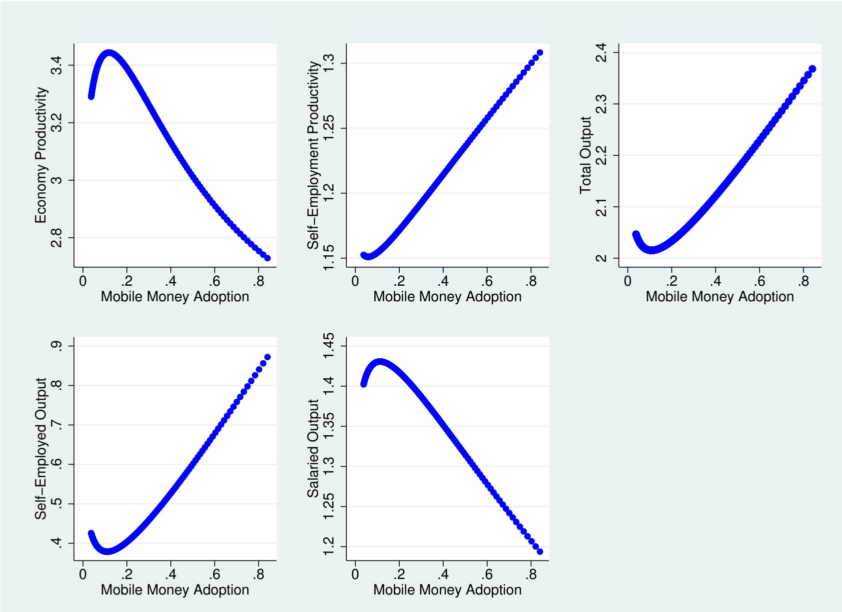
Note: Mobile money adoption is measured as a ratio of total active mobile money accounts divided by the number of households in the country.

Figure 4: Mobile money adoption and steady-state equilibria: benchmark model



Note: Graphs include model outputs for the number of self-employed firms as percentage of the labor force n_e/LFP, the unemployment rate, the measure of self-employment searchers se, the measure of salaried employment searchers s_s, the real wage w_s, vacancy postings v_s, the job filling probability $q(\theta)$ and the job finding probability $f(\theta)$ all measured against the mobile money adoption rate among self-employed firms.

Figure 5: Mobile money adoption and steady-state output and productivity variables: benchmark model



Note: Graphs include model outputs for economy-wide productivity, self-employment sector productivity, Total Output, Self-Employment Output and Salaried Firm Output, all measured against the mobile money adoption rate among self-employed firms.

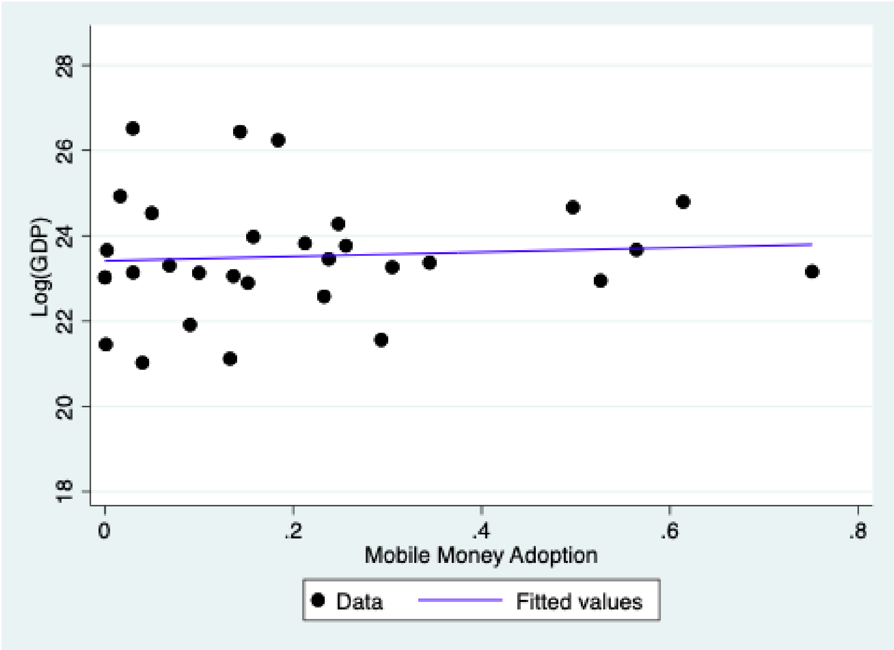
These dynamics in productivity and output can best be seen in the steady state results presented in Figure 5. Looking at the comparisons with the data, we can see that output also increases with mobile money growth, but that the relationship is quite weak (Figure 6). In addition, comparing labor force participation in the data and the model, we can see that the model fits the data poorly, as labor force participation reacts much more forcefully to an increase in mobile money adoption in the model than in the data (Figure 7). These figures illustrate that it is at best difficult make any robust assertions that increased mobile money adoption in the self-employed sector leads to expanded output in developing countries.

5.4 Unpacking the Link Between Mobile Money Adoption and Employment Dynamics

At a high level, the goal of this study to understand how one change (mobile money adoption) in the self-employment sector affects aggregate dynamics. As such, the magnitude of the effect of this change is directly linked to the key characteristics of the self-employment sector.

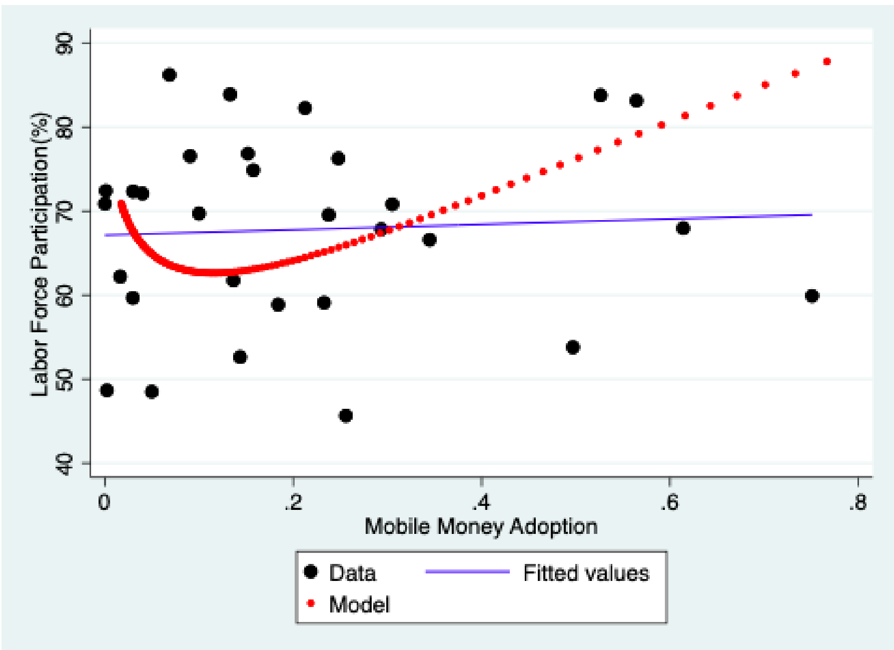
The main factor that defines the self-employment sector is the ease of entry into it. This can be explained intuitively. If the marginal cost of entry into the sector is high, then only a limited number of households will search for opportunities in this sector at a baseline. Conversely, a lower marginal cost means that more households will search for opportunities in this sector. In my model, the ease of entry into self-employment is represented by the exogenous probability of finding self-employment opportunities and entering self-employment (ϕ_e).

Figure 6: Mobile money adoption and GDP(Cross Country)



Note: The graph shows the cross-country relationships between GDP and mobile money. Log(GDP) is on the y-axis. GDP is in current($.)

Figure 7: Mobile money adoption and labor force participation: data vs. benchmark model



Note: The graph shows labor force participation on the y-axis, the model is shown in red and the data in black.

The level of ϕ_e affects how searchers respond to increasing mobile money adoption (i.e. an increase in aggregate self-employed firm productivity). Intuitively, the lower the ϕ_e, the harder is for individuals to enter into self-employment, and more importantly, the more households are willing to send individuals to search for self-employment opportunities amid increasing mobile money adoption. Put another way, if the marginal cost of entering self-employment is higher at a baseline, positive changes to the aggregate productivity of self-employment—due to increasing mobile money adoption— will have a more pronounced effect on search effort into self-employment than at a higher ϕ_e.

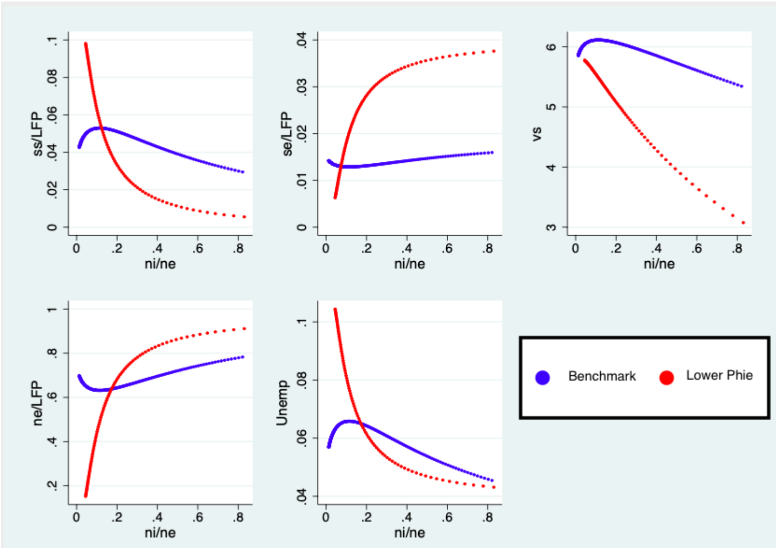
This is best seen in Figure 8, which compares steady state results in relation to changes in mobile money adoption for the benchmark model and a model with a lower exogenous probability of entry into self-employment(ϕ_e). In particular, I calibrate the alternate model so that marginal cost of entry into self-employment is about double the benchmark value (the actual value is 0.7495 vs. 1.5171 for baseline ϕ_e).

Narrowing in on the changes to the labor market variables with a lower ϕ_e, households respond by increasing the shares of individuals searching for self-employment opportunities (s_e/LFP) to a larger extent as mobile money adoption increases in the self-employment sector. At the same time, households also respond by decreasing the share of individuals searching for salaried sector opportunities (s_s/LFP) to a larger extent as I increase mobile money adoption. In particular, at a lower ϕ_e, the steeper decrease in the share of household's sending individuals to search for salaried opportunities pushes significant downward pressure on the unemployment rate, leading to a stronger negative relationship between mobile money adoption and unemployment as compared to the baseline model. This is best illustrated in Figure 10, which demonstrates how the benchmark model and the model with a lower ϕ_e compare against the actual trend in the data. It is also clearly apparent that the benchmark model better fits the weak negative relationship between mobile money and unemployment that is observed in the data.

The results for the effect of increasing mobile money adoption on the size of the self-employment sector as a percentage of total labor force participation (n_e/LFP) are similar. At a higher marginal cost of entry into self-employment (lower ϕ_e), households react by increasing entry into self-employment more forcefully as mobile money adoption increases in the self-employment sector. Based on the observed behavior of searchers, this makes intuitive sense as an increase in shares of individuals searching for self-employment will lead to a respective increase in entry into the self-employment sector. As a result, with a lower ϕ_e, I witness a much stronger positive relationship between self-employment and mobile money adoption. This can be clearly seen in Figure 9, which shows how the benchmark model and model with lower ϕ_e compare against the observed data. Again, one can see that the benchmark model fits the weak positive relationship between mobile money and self-employment that is observed in the data better than the model with lower ϕ_e.

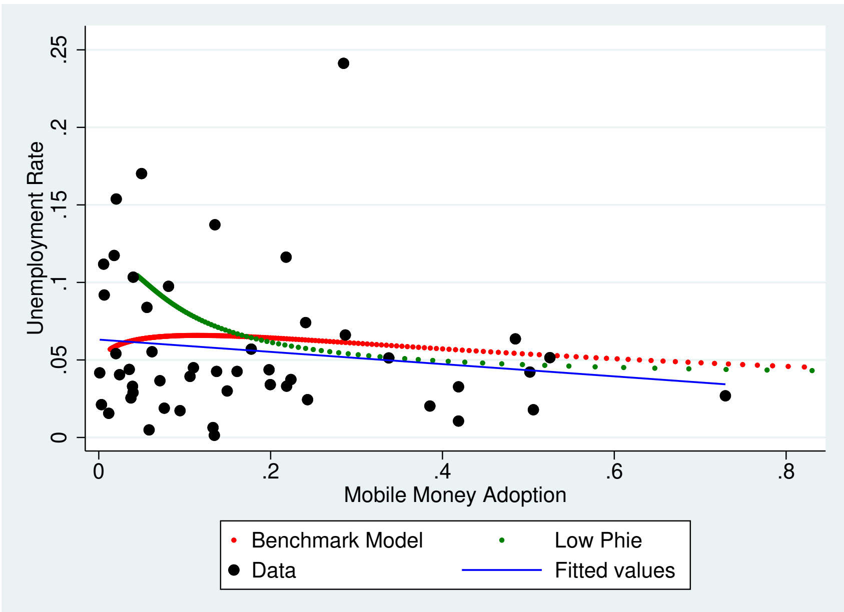
The takeaway from this exercise is that the barrier to entry into self-employment is a fundamental factor that shapes the link between mobile money adoption, unemployment and self-employment in developing countries. In particular, the above analysis shows that my benchmark value for ease of entry into self-employment (ϕ_e) generates model results that are consistent with the trends for self-employment and unemployment that are observed in the data.

Figure 8: Mobile money adoption and steady-state equilibria: benchmark model and with model with lower ϕ_e



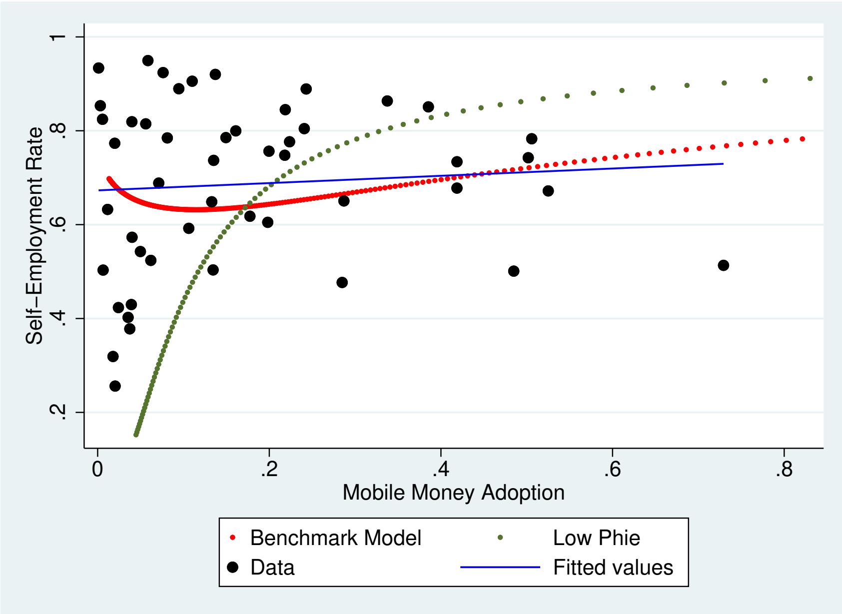
Note: Graphs include model results with the benchmark calibration and one with a lower effective cost of finding a self-employment opportunity ϕ_e. Above I show the results for the measure of salaried searchers as a percent of labor force participation s_s/LFP, self-employment searchers as a percent of labor force participation s_e/LFP, vacancy postings v_s, self-employed firms as a percent of labor force participation n_e/LFP, and the unemployment rate. The benchmark results are in blue while the results for lower ϕ_e are in red.

Figure 9: Mobile money adoption and Unemployment: data vs. benchmark model and with model with lower ϕ_e



Note: The figure shows the model output for unemployment at both the benchmark calibration and calibration with a lower ϕ_e.

Figure 10: Mobile money adoption and Self-Employment: data vs. benchmark model and with model with lower ϕ_e



Note: The figure shows the model output for self-employment at both the benchmark calibration and calibration with a lower ϕ_e.

6 Conclusion

In this paper, I study the link between owner-only firm adoption of mobile money and labor market outcomes in developing countries. Leveraging a sample of 49 developing countries, I build a two-sector labor search and matching model and endogenous self-employed firm entry to illuminate the economic mechanisms underlying these relationships. My model can generate the weak relationships between mobile money adoption, self-employment and unemployment observed in the data, while failing to replicate the relationships observed in the data between mobile money adoption and labor force participation.

In short, my analysis shows that reductions in fixed cost of mobile money usage in the self-employment sector lead to labor re-allocations away from the salaried sector and towards the self-employment sector. Specifically, these re-allocations lead to small and insignificant changes in the unemployment rate and self-employed rate. Critically, I also find that the labor re-allocations lead to an increase in self-employment output that more than offsets the respective decrease in salaried output. The result is an increase in economy-wide output as mobile money adoption increases. However, I note that it is difficult to make any robust assertions regarding this result as it is largely driven by a strong increase in labor force participation, which is not witnessed in the data.

These findings suggest that though mobile money adoption has a limited impact on the overall level of unemployment and the size of the salaried and self-employment sectors, it could have a positive effect on the overall level of production and output. What is more, my results also show that the adoption of mobile money can support policies geared towards inclusive growth. Specifically, in the context of my model mobile money adoption supports both wage and income growth for workers. Importantly, these changes are driven by productivity increases in the self-employment sector, which in low-income countries, is a sector comprised of workers who tend to be lower income and operate their businesses informally. From a policy perspective, these results support further interventions to reduce the costs of mobile cellular usage, which currently stand at 5.6% of GNI per capita in developing countries (ITU, 2021). In this context, such cost reduction policies could serve to support income gains for households at the bottom of the pyramid.

Finally, I must note that the findings in this paper are limited in several ways. Most importantly, a lack of data on mobile money usage among firms in developing countries, along with unreliable data on the true fixed cost of using the service, constrain my ability to make any forceful claims about the model's predictions. In addition, as mobile money adoption is still relatively nascent in most developing countries, it is difficult to disentangle any strong cross-country relationships between mobile money and aggregate outcomes. Finally, this study leaves out the extent to which increasing mobile money adoption improves the access of self-employed workers to a host of financial products from micro-loans to insurance, and to that end, how this access effects their outcomes. For example, in a study conducted on micro-enterprises run by women in Uganda, the author found that firms that received a micro-loan through their mobile money account witnessed 15% higher profits than firms who received the loan in cash, ceteris paribus (Riley, 2020). Further micro-economic research such as the one cited above will serve to shed more light on the overall pecuniary benefits of mobile money adoption for self-employed workers.

A Appendix

A.1 List of Countries

Afghanistan, Bangladesh, Benin, Bolivia, Burkina Faso, Cambodia, Cameroon, Central African Rep, Chad, Congo(DRC), Congo(Republic), Côte d'Ivoire, Egypt, El Salvador, Ethiopia, Ghana, Guinea, Guinea-Bissau, Haiti, Honduras, India, Kenya, Lesotho Liberia, Madagascar, Malawi, Mali, Mauritania, Mongolia, Morocco, Mozambique, Myanmar, Nicaragua, Niger, Nigeria, Pakistan, Philippines, Rwanda, Senegal, Sierra Leone, Solomon Islands, Sri Lanka, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

A.2 Equilibrium Conditions: Benchmark Model

Taking productivities $z_{ei,t}, z_{er,t}$ and z_t as given, the allocations and prices $[c_t, Y_{s,t}, Y_{e,t}, Y_t, p_{s,t}, p_{e,t}]$, and $[\widetilde{y}_{i,t}, \widetilde{y}_{r,t}, n_{s,t}, n_{e,t}, n_{i,t}, n_{r,t}, a_i, \widetilde{a}_{i,t}, \widetilde{a}_{r,t}, \widetilde{\rho}_{r,t}, \widetilde{\rho}_{i,t}, \omega_t, v_{s,t}, k_{i,t}, s_{s,t}, s_{e,t}, \widetilde{d}_t, \widetilde{d}_{i,t}, \widetilde{d}_{r,t}]$

$$Y_t = c_t + \psi_s v_{s,t} + k_{t+1} - (1-\sigma)k_{it} + f_i n_i \tag{22}$$

$$Y_{s,t} = z_t (n_{s,t})^{1-\alpha}(k_t)^{\alpha} \tag{23}$$

$$Y_{e,t} = (n_i(\widetilde{y}_{i,t})^{\frac{\epsilon-1}{\epsilon}} + n_r(\widetilde{y}_{r,t})^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}} \tag{24}$$

$$\widetilde{y}_{i,t} = (\frac{\widetilde{p_{i,t}}}{p_{e,t}})^{\epsilon} Y_{e,t} \tag{25}$$

$$\widetilde{y}_{r,t} = (\frac{\widetilde{p_{r,t}}}{p_{e,t}})^{\epsilon} Y_{e,t} \tag{26}$$

$$w_{s,t} = v(z_t p_{s,t} F_{n_{s,t}}) + (1-v)\frac{h_{lfp_{s,t}}}{u'(c_t)} \tag{27}$$

$$Y_t = [Y_{s,t}^{\frac{\phi_y-1}{\phi_y}} + Y_{e,t}^{\frac{\phi_y-1}{\phi_y}}] \tag{28}$$

$$Y_{s,t} = (p_{s,t})^{-\phi_y} Y_t \tag{29}$$

$$Y_{e,t} = (p_{e,t})^{-\phi_y} Y_t \tag{30}$$

$$1 = \Xi_{t|t+1}[p_{s,t+1} z_{t+1} F_{k,t+1} + (1-\sigma)] \tag{31}$$

$$\frac{\psi_s}{q(\theta_{s,t})} = (1-\rho_s)\Xi_{t+1|t}[p_{s,t+1} z_{t+1} F_{n_s,t+1} - w_{s,t+1} + \frac{\psi_s}{q(\theta_{s,t+1})}] \tag{32}$$

$$d_{i,t}(a_{i,t}) = d_{r,t}(a_{i,t}) \tag{33}$$

$$n_{s,t+1} = (1-\rho_s)[n_{s,t} + s_{j,t} f(\theta_{j,t})] \tag{34}$$

$$n_{e,t+1} = (1-\rho_e)[n_{e,t} + s_{e,t}\phi_e] \tag{35}$$

$$\frac{h_{lfp_{e,t}}}{u'(c_t)}\frac{1}{\phi_i} = (1-\rho_e)\Xi_{t+1|t}[\widetilde{d}_{t+1} + \frac{h_{lfp_{e,t+1}}}{u'(c_{t+1})}(\frac{1}{\phi_i} - 1)] \tag{36}$$

$$\frac{h_{lfp_{s,t}}}{u'(c_t)}\frac{1}{f(\theta_{s,t})} = (1-\rho_s)\Xi_{t+1|t}[w_{s,t+1} + \frac{h_{lfp_{s,t+1}}}{u'(c_{t+1})}(\frac{1}{f(\theta_{j,t+1})} - 1)] \tag{37}$$

$$n_{i,t} = (\frac{a_{min}}{a_{i,t}})^{k_p} n_{e,t} \tag{38}$$

$$\widetilde{a}_{i,t} = (\frac{k_p}{k_p - (\epsilon-1)})^{\frac{1}{\epsilon-1}} a_{i,t} \tag{39}$$

$$\widetilde{a}_{r,t} = \widetilde{a}_{i,t}([\frac{a_{i,t}^{k_p-(\epsilon-1)} - a_{min}^{k_p-(\epsilon-1)}}{a_{i,t}^{k_p} - a_{min}^{k_p}}])^{\frac{1}{1-\epsilon}} \tag{40}$$

$$\widetilde{p}_{i,t} = \frac{\epsilon}{\epsilon-1}\frac{mc_{i,t}}{\widetilde{a}_{i,t}} \tag{41}$$

$$\widetilde{p}_{r,t} = \frac{\epsilon}{\epsilon-1}\frac{mc_{r,t}}{\widetilde{a}_{r,t}} \tag{42}$$

$$n_{r,t} = n_{e,t} - n_{i,t} \tag{43}$$

$$\tilde{y}_{i,t} = \tilde{a}_{i,t} z_{ei,t} \tag{44}$$

$$\tilde{y}_{r,t} = \tilde{a}_{r,t} z_{er,t} \tag{45}$$

$$\tilde{d}_t = \frac{n_{i,t}}{n_{e,t}} \tilde{d}_{i,t} + \frac{n_{r,t}}{n_{e,t}} \tilde{d}_{r,t} \tag{46}$$

$$\tilde{d}_{i,t} = (\tilde{\rho}_{i,t} - \frac{mc_t}{\tilde{a}_{i,t}}) \tilde{y}_{i,t} - f_i \tag{47}$$

$$\tilde{d}_{r,t} = (\tilde{\rho}_{r,t} - \frac{mc_t}{\tilde{a}_{r,t}}) \tilde{y}_{r,t} \tag{48}$$

A.3 Robustness Checks

Figure 11: Mobile money adoption, Self-Employment and Unemployment: data vs. benchmark model and model with higher relative risk aversion σ_c

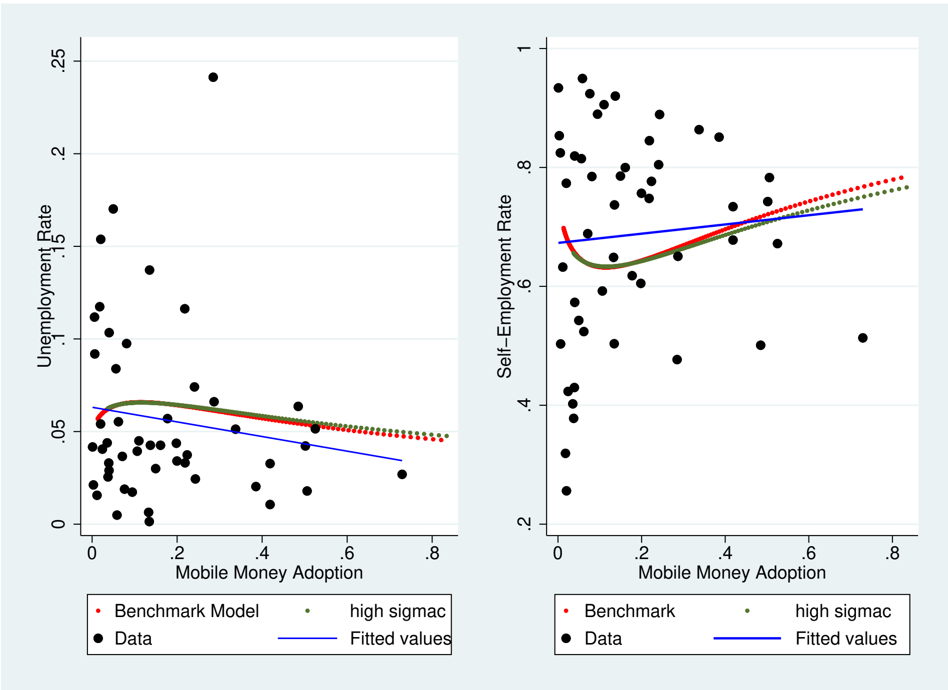


Figure 12: Mobile money adoption, Self-Employment and Unemployment: data vs. benchmark model and model with lower elasticity of substitution between salaried and self-employment output ϕ_y

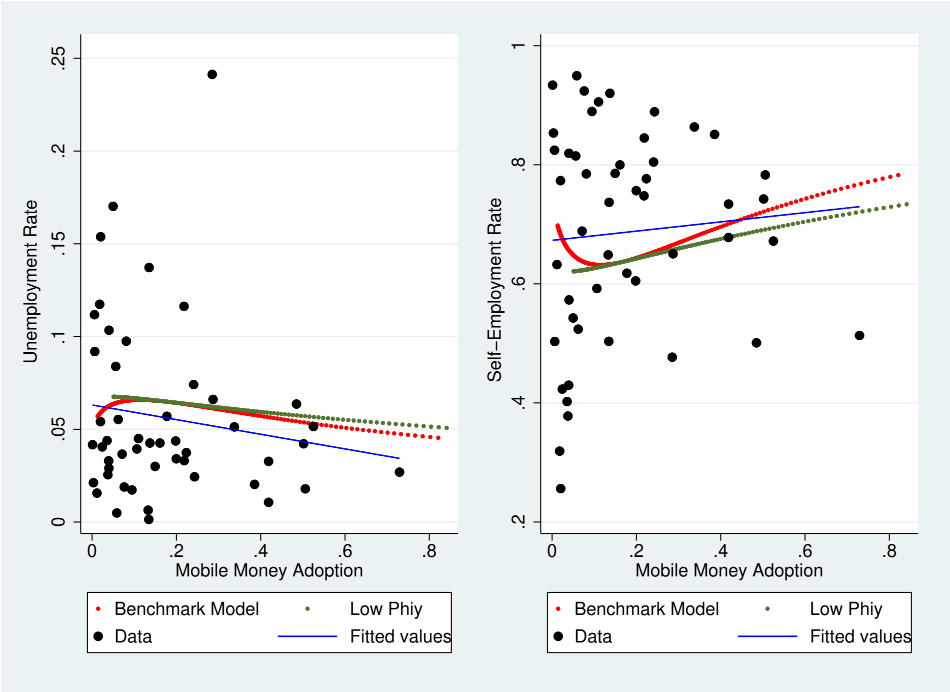


Figure 13: Mobile money adoption, Self-Employment and Unemployment: data vs. benchmark model and model with higher lower elasticity of substitution between salaried and self-employment output ϕ_y

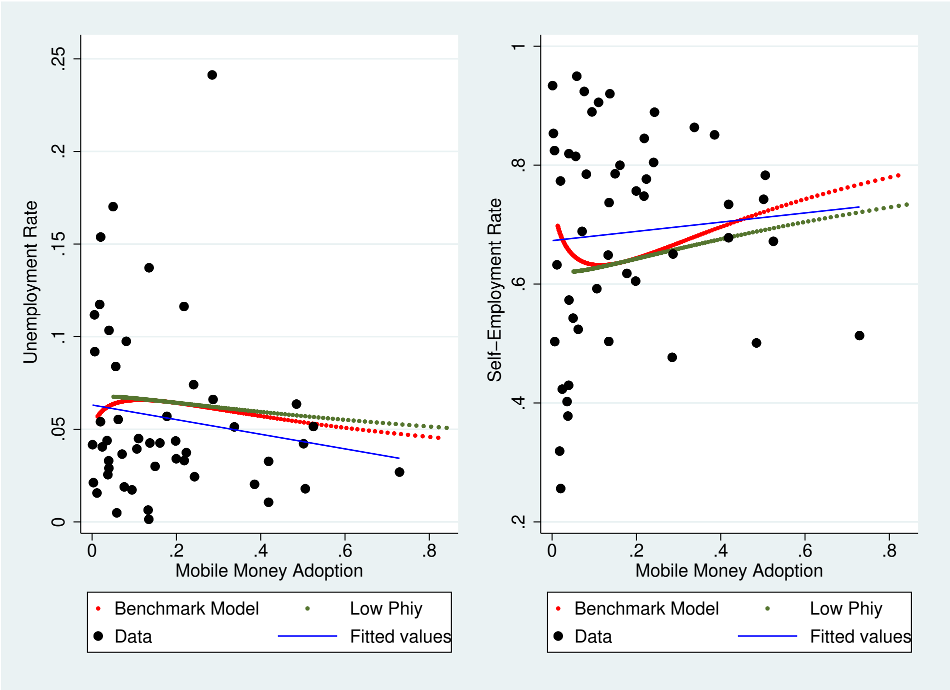


Figure 14: Mobile money adoption, Self-Employment and Unemployment: data vs. benchmark model and model with higher elasticity of substitution between salaried and self-employment output ϕ_y

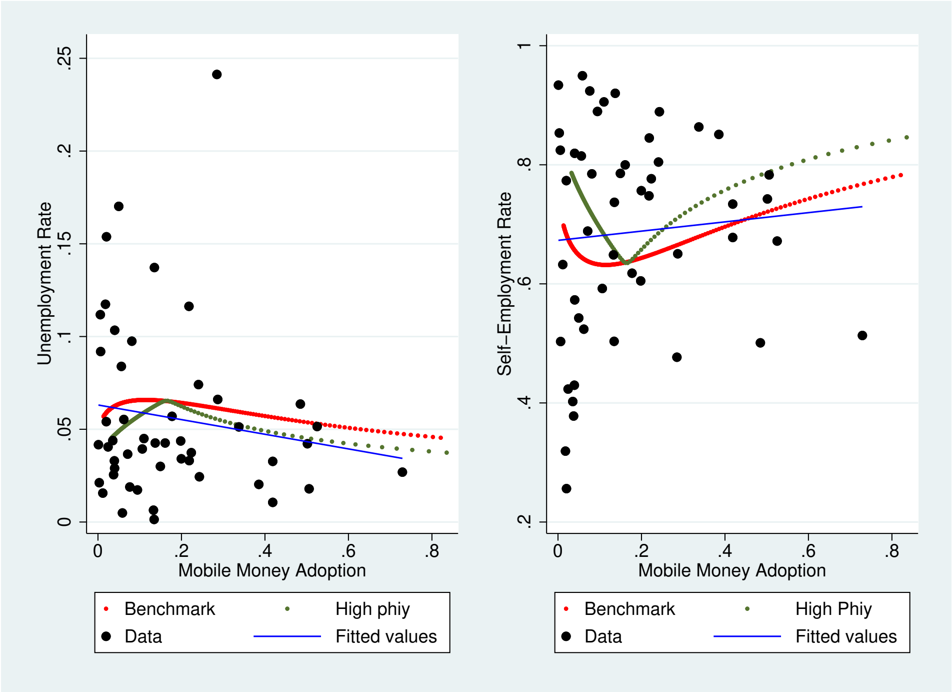
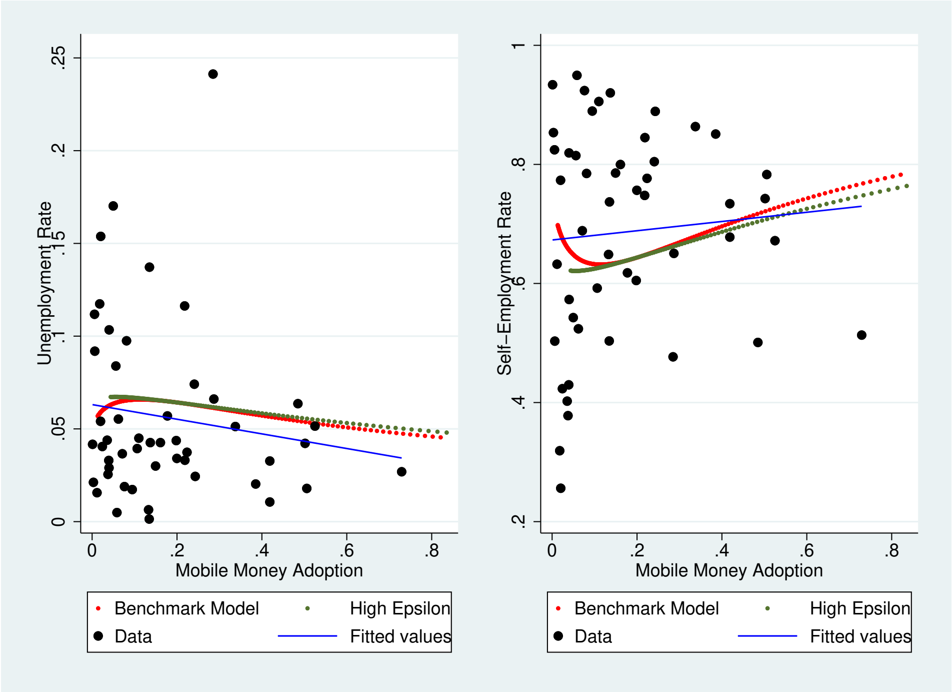


Figure 15: Mobile money adoption, Self-Employment and Unemployment: data vs. benchmark model and model with higher elasticity of substitution self-employment varieties ϵ



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